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ORIGINAL RESEARCH

COMPARISON OF NON-CONTACT AND CONTACT TIME-LOSS LOWER QUADRANT INJURY RATES IN MALE COLLEGIATE BASKETBALL PLAYERS: A PRELIMINARY REPORT

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ABSTRACT

Background: Male collegiate basketball (BB) players are at risk for musculoskeletal injury. The rate of time-loss injury in men's collegiate BB, for *all* levels of National Collegiate Athletic Association (NCAA) competition, ranges from 2.8 to 4.3 per 1000 athletic exposures (AE) during practices and 4.56 to 9.9 per 1000 AE during games. The aforementioned injury rates provide valuable information for sports medicine professionals and coaching staffs. However, many of the aforementioned studies do not provide injury rates based on injury mechanism, region of the body, or player demographics.

Hypothesis/ Purpose: The purpose of this study is two-fold. The first purpose of this study was to report lower quadrant (LQ = lower extremities and low back region) injury rates, per contact and non-contact mechanism of injury, for a cohort of male collegiate basketball (BB) players. The second purpose was to report injury risk based on prior history of injury, player position, and starter status.

Study Design: Prospective, descriptive, observational cohort

Methods: A total of 95 male collegiate BB players (mean age 20.02 $\pm$ 1.68 years) from 7 teams (NCAA Division II = 14, NCAA Division III = 43, NAIA = 21, community college = 17) from the Portland, Oregon region were recruited during the 2016-2017 season to participate in this study. Each athlete was asked to complete an injury history questionnaire. The primary investigator collected the following information each week from each team's athletic trainer: athletic exposures (AE; 1 AE = game or practice) and injury updates.

Results: Thirty-three time-loss LQ injuries occurred during the study period. The overall time-loss injury rate was 3.4 per 1000 AE. Division III BB players had the highest rates of injury. There was no difference in injury rates between those with or without prior injury history. Guards had a significantly greater rate of non-contact time-loss injuries (p = 0.04).

Conclusions: Guards experienced a greater rate of LQ injury than their forward/center counterparts. Starters and athletes with a prior history of injury were no more likely to experience a non-contact time-loss injury than nonstarters or those without a prior history of injury. These preliminary results are a novel presentation of injury rates and risk for this population and warrant continued investigation.

Level of Evidence: 2

Keywords: basketball, college, epidemiology, prior history of injury

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INTRODUCTION

Male collegiate basketball (BB) players are at risk for musculoskeletal injury.[1-4] The rate of time-loss injury in men's collegiate BB, for *all* levels of National Collegiate Athletic Association (NCAA) competition, ranges from 2.8 to 4.3 per 1000 athletic exposures (AE) during practices and 4.56 to 9.9 per 1000 AE during games.[1,2] Men's basketball ranks fourth; only behind football, wrestling, and soccer in overall time-loss injury rates at the collegiate level.[3] Lateral ankle sprains, internal derangement at the knee, patellar tendinopathy, and muscular strains are the most common injuries experienced by BB players during either practices or games.[1,2,4-9]

The majority of injuries experienced by male collegiate BB players involve the lower extremities and the low back region.[1] Dick et al reported 60.6 percent of injuries that happen during practice and 57.9 percent of injuries happen during games occurred in the lower extremities.[1] Another 11.4 and 13.5 percent of all injuries (occurring during practices and games respectively) involved the trunk/back region.[1]

Many of the aforementioned epidemiological studies do not provide injury rates based on sport-related demographics (e.g., player position or starter status), injury mechanism (MOI), prior history of injury, and/or region of the body.[1-9] Calculating injury rates based on demographics, prior injury history, or MOI may provide insights that may help with the development of injury reduction programs and/or off-season training regimens.[10-13]

There is a gap in literature regarding specific injury rates in male collegiate BB players. Therefore, the purpose of this study is two-fold. The first purpose of this study was to report lower quadrant (LQ = lower extremities and low back region) injury rates, per contact and non-contact MOI, for a cohort of male collegiate BB players. It was hypothesized that BB players with a prior history of injury, or who were a forward or center, or who were starters would have a greater risk of LQ injury than those without prior injury history, or who were a guard, or who were a non-starter. The second purpose was to report injury risk based on prior history of injury, player position, and starter status. It was hypothesized that athletes with a prior history of injury or who were a forward/center or who were a starter would have a significantly greater risk of LQ injury than their counterparts.

METHODS

Participants

A total of 95 male collegiate BB players (mean age 20.02 $\pm$ 1.68 years) from seven teams (NCAA Division II = 14, NCAA Division III = 43, NAIA = 21, community college = 17) from the Portland, Oregon region were recruited during the 2016-2017 season to participate in this study. The data presented in this study is part of a larger, ongoing, multi-year epidemiologic study of risk factors associated with men's collegiate basketball. An athlete was excluded from participation in this study if he was under the age 18 at the start of the season. The Institutional Review Board of George Fox University approved this study. Informed consent was provided by each athlete prior to study participation.

Procedures

Injury History Questionnaire

Each athlete was asked to complete an injury history questionnaire providing the following information: prior sport-related injury history (yes/no), injury location (e.g., right ankle), diagnosis (e.g., sprain, strain, etc.), and if the injury resulted in time-loss from sport.

Player Position and Starter Status

Team statistics were reviewed at the end of the season in order to identify primary player position and starter status. Players were categorized into two player position groups: guards and forwards/centers. Centers were combined with forwards in this study due to the overall low number of centers available for this study [note: some teams did not even designate one player as a center]. BB players were also categorized by starter status: starters and non-starters. A review of team records identified the athletes from each team who were the primary starters. Only 34 players (instead of 35; 5 starters per 7 teams) were identified as starters because a starter from one NAIA team did not complete preseason testing.

Injury Surveillance

The primary investigator collected the following information each week from the team's athletic trainer: athletic exposures (AE; 1 AE = game or practice) and injury updates. Injured athletes were evaluated by their team's athletic trainer. The operational definition of an injury was any musculoskeletal injury of the low back or the lower extremity that occurred either during practice or during a game that required the athlete to be removed from that day's event or to miss a subsequent practice or competition.[14,15] If an athlete was injured the following information was collected: mechanism of injury (contact or non-contact), location (e.g., body part and side of body), diagnosis (e.g., sprain, strain, etc.), and days missed from competition.

Statistical Analyses

Initial, subsequent, and total injury rates were calculated per level of competition. An "initial" injury was defined as the first musculoskeletal injury experienced by an athlete involving the LQ region. A "subsequent" injury was defined as any musculoskeletal injury to the LQ region experienced after an athlete's initial injury (note: a subsequent injury could be any injury and not a recurrence of the initial injury). Injury rates based on MOI (e.g., contact or non-contact) were calculated per level of play based on prior history of sport-related injury. Initial and subsequent injury rates were also calculated based on player position and starter status. Injury rates and rate ratios (RR) were calculated using OpenEpi. Univariate logistic regression analysis was performed to calculate odds ratios (OR) and 95% confidence intervals (CIs). The authors utilized a previously reported sample size estimation of 67 subjects to determine statistically significant associations between LQ injury and potential risk factors.[5] For each logistic regression model athletes were categorized into the following groups: 1) prior history of injury [at risk]/ no prior injury history [reference]; 2) prior history of ankle sprain [at risk]/ no prior history of ankle sprain [reference]; 3) guard [reference] / forwards/ centers [at risk]; 4) starter [at risk] / non-starter [reference]. Logistic regression analysis was performed using SPSS 24 (Chicago, IL) with alpha level set at 0.05.

RESULTS

A total of 29 initial and four subsequent LQ injuries were experienced by male collegiate BB players during the course of this study (Table 1). Injury mechanisms were categorized as either contact (e.g., injury occurring due to contact/collision with another player) or non-contact (e.g., injury mechanism not related to contact/collision with another player). Fifteen of the 29 initial LQ injuries occurred during practice (51.7%). The majority of time-loss injuries (73.3%) that occurred during practice had a non-contact mechanism. A non-contact injury mechanism was also responsible for a majority of LQ time-loss injuries (77%) occurring during games. The four subsequent LQ time-loss injuries occurred in practice with three of the four injuries (75%) due to a non-contact mechanism.

Table 2 presents the injury rates (initial and subsequent) for the total population (n = 95) and per level of competition. The overall LQ time-loss injury rate (including injuries from both contact and non-contact mechanisms) for the entire population was 3.4 (95% CI: 2.3, 4.7) per 1000 AE. Division III athletes had the highest rates of initial and subsequent injuries.

Table 3 presents lower quadrant (LQ) time-loss injury rates for non-contact, contact, and "all injury mechanisms" categorized by prior history of sport-related injury. Division III BB players had the highest rates of non-contact time-loss LQ injury based on prior history of injury. There was no difference in non-contact time-loss LQ injury rates between players with prior injury history [2.6 (95% CI: 1.7, 3.9) per 1000 AE] and players with no prior history [1.3 (95% CI: 0.2, 4.4) per 1000 AE] for the total population [RR = 2.0 (95% CI: 0.5, 12.5) p = 0.3].

Table 4 compares injury rates between player positions categorized as either: guards or forwards/ centers. Guards experienced a significantly greater overall rate of non-contact time-loss LQ injury than their forward/center counterparts [(RR = 0.4 (0.1, 1.0) p = 0.04). Note: the aforementioned RR is based on forwards/centers having been designated as "at risk". If guards were designated as "at risk" the RR would be 2.6 (1.0, 7.6)]. No differences in injury rates based on contact MOI or the combined MOI category "all injuries" were observed between player positions.

Table 1. *Injury Categorization based on Mechanism (e.g., Non-Contact or Contact), Diagnoses, and Average Time-Loss from Sport.*

Mechanism of Injury & Diagnosis	Injury Count		Average Number of Missed Athletic Exposures	Range of Missed Athletic Exposures [If more than one injury per category]
	Right	Left		
Non-Contact Mechanism				
Initial Injuries (n = 21)				
Lumbar strain	Not applicable		14	
Hip flexor strain	2	1	4.6	2-7
Knee sprain [NOS]	1	2	5	1-10
Anterior cruciate ligament sprain	1	1	72	
Medial collateral ligament sprain			12	4-20
Hamstring strain	0	1	3	
Gastrocnemius strain	1	0	7	
Achilles tendon tendinitis	1	1	4.5	2-7
Lateral ankle sprain	3	4	5.1	2-8
Subsequent Injuries (n = 3)				
Hip flexor strain	1	0	3	
Groin strain	0	1	5	
Lateral ankle sprain	0	1	4	
Contact Mechanism				
Initial Injuries (n = 8)				
Knee sprain [NOS]	0	1	2	
Anterior cruciate ligament sprain	1	0	43	
Lateral ankle sprain	3	3	6.6	2-16
Subsequent Injury (n = 1)				
Knee sprain [NOS]	0	1	3	

NOS = not otherwise specified

Table 2. *Initial and Subsequent Lower Quadrant Time Loss Injury Rates: Analysis per Level of Competition and Overall Population. All Injuries, Regardless of Mechanism, were Included in this Analysis.*

	Initial Injury			Subsequent Injury			Total Injuries		
	No.	AEs	Rate (95% CI)	No.	AEs	Rate (95% CI)	No.	AEs	Rate (95% CI)
Division II (n = 14)	1	1350	0.7 (0.0, 3.7)	0	54	0.0	1	1404	0.7 (0.0, 3.5)
Division III (n = 43)	17	3355	5.1 (3.1, 7.9)	4	678	5.9 (1.9, 14.2)	21	4033	5.2 (3.3, 7.8)
NAIA (n = 21)	5	1970	2.5 (0.9, 5.6)	0	217	0.0	5	2187	2.3 (0.8, 5.1)
Community College (n = 17)	6	1740	3.5 (1.4, 7.2)	0	473	0.0	6	2213	2.7 (1.1, 5.6)
Total Population (n = 95)	29	8415	3.4 (2.4, 4.9)	4	1422	2.8 (0.9, 6.8)	33	9837	3.4 (2.3, 4.7)

CI = confidence interval
AE = athletic exposure
Rate: Injury rate per 1000 athletic exposures

Table 5 compares injury rates between starters and non-starters. There was no difference in injury rates between starters and non-starters for non-contact, contact, or all injury mechanisms categories.

Table 6 presents odds ratios (OR) associated with prior injury history, player position, and starter status. Prior injury history (either all prior injuries or prior ankle sprain injuries) was not associated with greater risk of either a non-contact LQ injury or a non-contact ankle sprain. Player position was not associated with an increased risk of injury; however, there was a trend towards guards having a significantly greater risk of injury [OR = 2.9 (95% CI: 0.9, 9.5) p = 0.08).

DISCUSSION

As mentioned previously the purpose of this study was two-fold. The first purpose was to report injury

Table 3. *Lower Quadrant Injury Rates (Non-Contact, Contact, and All Injury Mechanisms) in Male Collegiate Basketball Players based on Prior History of Sport-Related Injury.*

Injury Mechanism	Total			Prior History Injury			No History Injury			Rate Ratio† (95% CI)
	No.	AEs	Rate (95% CI)	No.	AEs	Rate (95% CI)	No.	AEs	Rate (95% CI)	
Injury Rates: Non-Contact										
Division II (n = 14)	1	1404	0.7 (0.0, 3.5)	1	1303	0.8 (0.0, 3.8)	0	101	0.0	
Division III (n = 43)	19	4033	4.7 (2.9, 7.2)	18	3747	4.8 (2.9, 7.4)	1	286	3.5 (0.2, 17.2)	1.4 (0.3, 29.0) $p = 0.9$
NAIA (n = 21)	1	2187	0.5 (0.0, 2.3)	1	1858	0.5 (0.0, 2.7)	0	329	0.0	
Community College (n = 17)	3	2213	1.4 (0.0, 3.7)	2	1427	1.4 (0.2, 4.6)	1	786	1.3 (0.1, 6.3)	1.1 (0.1, 32.5) p = 0.9
Total Population (n = 95)	24	9837	2.4 (1.6, 3.6)	22	8335	2.6 (1.7, 3.9)	2	1502	1.3 (0.2, 4.4)	2.0 (0.5, 12.5) $p = 0.3$
Injury Rates: Contact										
Division II (n = 14)	0	1404	0.0	0	1303	0.0	0	101	0.0	
Division III (n = 43)	2	4033	0.5 (0.1, 1.6)	2	3747	0.5 (0.1, 13.2)	0	286	0.0	
NAIA (n = 21)	4	2187	1.8 (0.6, 4.4)	4	1858	2.2 (0.7, 5.2)	0	329	0.0	
Community College (n = 17)	3	2213	1.4 (0.0, 3.7)	2	1427	1.4 (0.2, 4.6)	1	786	1.3 (0.1, 6.3)	1.1 (0.1, 32.5) $p = 0.9$
Total Population (n = 95)	9	9837	0.9 (0.4, 1.7)	8	8335	1.0 (0.4, 1.8)	1	1502	0.7 (0.0, 3.3)	0.1 (0.2, 3.2) $p = 0.8$
Injury Rates: All										
Division II (n = 14)	1	1404	0.7 (0.0, 3.5)	1	1303	0.8 (0.0, 3.8)	0	101	0.0	
Division III (n = 43)	21	4033	5.2 (3.3, 7.8)	20	3747	5.3 (3.4, 8.1)	1	286	3.5 (0.2, 17.2)	1.5 (0.3, 32.0) p = 0.8
NAIA (n = 21)	5	2187	2.3 (0.8, 5.1)	5	1858	2.7 (1.0, 6.0)	0	329	0.0	
Community College (n = 17)	6	2213	2.7 (1.1, 5.6)	4	1427	2.8 (0.9, 6.8)	2	786	2.5 (0.4, 8.4)	1.1 (0.2, 8.6) p = 0.9
Total Population (n = 95)	33	9837	3.4 (2.3, 4.7)	30	8335	3.6 (2.4, 5.1)	3	1502	2.0 (0.4, 5.8)	1.8 (0.6, 7.4) $p = 0.3$

CI = confidence interval
AE = athletic exposure
Rate: Injury rate per 1000 athletic exposures
†Rate Ratio: comparison between 2 rates; comparison between athletes with prior injury history and those with no prior history of injury.

rates, categorized by MOI, per prior injury history, player position, and starter status. The overall LQ injury (e.g., "all injury mechanisms") rate of 3.4 (95% CI: 2.3, 4.7) per 1000 AE was below previously reported rates; however, this likely due to the exclusion of upper quadrant related musculoskeletal injuries, concussions, and other non-musculoskeletal time-loss injuries. A unique aspect of this study is the reporting of non-contact time-loss LQ injury rates. The injury rate associated with time-loss LQ injury due to a non-contact MOI was 2.4 (95% CI: 1.6, 3.6) per 1000 AE.

The second purpose of this study was to report injury risk based on prior injury history, player position, and starter status. It was hypothesized that BB players with a prior history of injury would be at a greater risk of LQ injury during the season. In this study BB players with a prior sport-related injury were no more likely to be injured during the course of the study when compared with BB players with no prior injury history. This is an interesting finding that warrants discussion. Prior history of sport injury has been identified as a risk factor for subsequent injury; however, it appears that this relationship is specific to injury type.[16-23] For example, a prior hamstring strain, or ankle sprain, or an anterior cruciate ligament (ACL) sprain are risk factors for a recurring hamstring strain, recurring ankle sprain, or secondary ACL sprain respectively.[16-23] It can be argued that prior injury, if not optimally rehabilitated, may leave the athlete with deficits of

Table 4. *Lower Quadrant Injury Rates (Non-Contact, Contact, and All Injury Mechanisms) in Male Collegiate Basketball Players per Player Position: Guards vs. Forwards/Centers.*

Injury Mechanism	Total			Guards			Forwards/Centers			Rate Ratio† (95% CI)
	No.	AEs	Rate (95% CI)	No.	AEs	Rate (95% CI)	No.	AEs	Rate (95% CI)	
Injury Rates: Non-Contact										
Onset										
Initial	21	8375	2.5 (1.6, 3.8)	16	5189	3.1 (1.8, 4.9)	5	3186	1.6 (0.6, 3.5)	0.5 (0.2, 1.3) $p = 0.18$
Subsequent	3	1462	2.1 (0.5, 5.6)	3	1110	2.7 (0.7, 7.4)	0	352	0.0	Not calculated
Total	24	9837	2.4 (1.6, 3.6)	23	6299	3.7 (2.4, 5.4)	5	3538	1.4 (0.5, 3.1)	0.4 (0.1, 1.0) $p = 0.04$
Injury Rates: Contact										
Onset										
Initial	8	8375	1.0 (0.4, 1.8)	5	5189	1.0 (0.4, 2.1)	3	3186	0.9 (0.2, 2.6)	0.1 (0.0, 0.4) $p = 0.9$
Subsequent	1	1462	0.7 (0.0, 3.3)	0	1110	0.0	1	352	2.8 (0.1, 14.0)	
Total	9	9837	0.9 (0.4, 1.7)	5	6299	0.8 (0.3, 1.8)	4	3538	1.1 (0.4, 2.7)	0.1 (0.0, 0.6) $p = 0.6$
Injury Rates: All										
Onset										
Initial	28	8375	3.3 (2.3, 4.8)	21	5189	4.0 (2.6, 6.1)	7	3186	2.2 (1.0, 4.3)	0.5 (0.2, 1.2) $p = 0.2$
Subsequent	4	1462	2.7 (0.9, 6.6)	4	1110	3.6 (1.1, 8.7)	1	352	2.8 (0.1, 14.0)	0.8 (0.0, 6.3) $p = 0.9$
Total	33	9837	3.4 (2.3, 4.7)	25	6299	4.0 (2.6, 5.8)	8	3538	2.3 (1.1, 4.3)	0.6 (0.2, 1.2) $p = 0.2$

CI = confidence interval
AE = athletic exposure
Rate: Injury rate per 1000 athletic exposures
†Rate Ratio: comparison between 2 rates; comparison between guards (reference) versus forwards/centers (at-risk)

Table 5. *Lower Quadrant Injury Rates (Non-Contact, Contact, and All Injury Mechanisms) in Male Collegiate Basketball Players per Playing Status: Starters vs. Non-Starters.*

Injury Mechanism	Total			Starters			Non-Starters			Rate Ratio† (95% CI)
	No.	AEs	Rate (95% CI)	No.	AEs	Rate (95% CI)	No.	AEs	Rate (95% CI)	
Injury Rates: Non-Contact										
Onset										
Initial	21	8375	2.5 (1.6, 3.8)	7	2796	2.5 (1.0, 5.2)	14	5579	2.5 (1.4, 4.2)	1.0 (0.4, 2.5) $p = 0.9$
Subsequent	3	1462	2.1 (0.5, 5.6)	0	664	0.0	3	798	3.8 (1.0, 10.2)	
Total	24	9837	2.4 (1.6, 3.6)	7	3460	2.0 (0.8, 4.2)	17	6377	2.7 (1.6, 4.3)	0.8 (0.3, 1.8) $p = 0.6$
Injury Rates: Contact										
Onset										
Initial	8	8375	1.0 (0.4, 1.8)	4	2796	1.4 (0.5, 3.5)	4	5579	0.7 (0.2, 1.7)	0.2 (0.0, 0.8) $p = 0.3$
Subsequent	0	1462	0.0	0	664	0.0	1	798	1.3 (0.0, 6.2)	
Total	9	9837	0.9 (0.4, 1.7)	4	3460	1.2 (0.3, 3.0)	5	6377	0.8 (0.3, 1.8)	0.1 (0.0, 0.6) $p = 0.6$
Injury Rates: All										
Onset										
Initial	29	8375	3.5 (2.4, 4.9)	11	2796	3.9 (2.0, 7.0)	18	5579	3.2 (1.9, 5.1)	1.2 (0.6, 2.6) $p = 0.6$
Subsequent	4	1462	2.7 (0.9, 6.6)	0	664	0.0	4	798	5.0 (1.6, 12.1)	
Total	33	9837	3.4 (2.3, 4.7)	11	3460	3.2 (1.6, 5.7)	22	6377	3.5 (2.2, 5.2)	0.9 (0.4, 1.9) $p = 0.8$

CI = confidence interval
AE = athletic exposure
Rate: Injury rate per 1000 athletic exposures
†Rate Ratio: comparison between 2 rates; comparison between starters (at-risk) and non-starters (reference)

Table 6. *Odds Ratios Associated with Prior Injury History, Player Position, or Starter Status.*

Variable	N at risk	All Non-Contact Injuries (%) per Category	Odds Ratio (95% CI)	Non-Contact Ankle Sprain (%) per Category	Odds Ratio (95% CI)
Prior History of Sport-Related Time Loss Injury					
Yes	81	(24)	1.9 (0.4, 9.0)	(7)	1.0 (0.1, 9.4)
No	14	(10)	1.0 (Reference)	(7)	1.0 (Reference)
Prior History of Ankle Sprain					
Yes	33	(24)	1.2 (0.4, 3.3)	(12)	2.7 (0.6, 12.9)
No	62	(21)	1.0 (Reference)	(5)	1.0 (Reference)
Position					
Guard	61	(28)	2.9 (0.9, 9.5)	(8)	1.4 (0.3, 7.8)
Forward/Center	34	(12)	1.0 (Reference)	(6)	1.0 (Reference)
Starter Status					
Starter	34	(21)	0.8 (0.3, 2.3)	(9)	1.4 (0.2, 7.1)
Non-Starter	61	(23)	1.0 (Referent)	(7)	1.0 (Referent)

muscular strength, flexibility, and/or other domains that would increase that athlete's risk for future injury. For example, lower extremity strength deficits, represented by shorter triple hop distance and side-to-side limb asymmetry during the triple jump, are components of a clinical profile associated with one having a higher risk of a second ACL injury.[24] However, having had a prior LQ sport-related injury does not increase the likelihood for *any* type of sport-related LQ injury in a sample of male collegiate BB players. Prior history of ankle sprain (regardless of side) was also not associated with a sport-related non-contact ankle sprain in this study. This was an interesting finding because prior studies have identified a prior history of an ankle sprain as a risk factor for recurrent ankle sprains in basketball players.[7,8,25,26] It is possible that a lack of relationship between prior ankle sprain injury and subsequent ankle sprain injury was due to one or more factors. First, analysis of subsequent ankle sprain injury was restricted to those with a noncontact MOI. Second, it is possible that athletes with a prior history of lateral ankle sprains may have been utilizing prophylactic measures (e.g., bracing or taping) therefore reducing their risk of reinjury.[27,28] Third, it is possible that no relationship was found due to the limited sample size in this preliminary report (type II error).

It was hypothesized that forwards/centers would be at greater risk for injury than guards. This hypothesis was based on prior reports and positional requirements.[4,9] For example, forwards and centers may spend more time playing in and around the key region. As a result, there may be a greater chance for repeated physical contact (e.g., blocking out for rebounds) and there may be greater exposure to certain injuries due to repetitive jumping (e.g., jumper's knee or bone stress injuries).[29,30] Starkey[9] reported National Basketball Association (NBA) forwards had the highest game-related injury rate of 21.7 per 1000 AEs, followed closely by NBA guards at 21.3 per 1000 AEs, and finally NBA centers at 21.0 per 1000 AEs. However, it is important to note that this injury rate was for games only, included injuries for the entire body, and did not differentiate injuries based on MOI.[9] Meeuwise et al[4] reported injury rates for male collegiate BB players from Canada. In that study centers experienced the highest injury rates per mechanism: contact (27.12 per 1000 AEs) and non-contact (36.16 per 1000 AEs).[4] Centers also experienced a significantly greater rate of injury per knee, ankle, and foot regions when compared to forwards.[4] In addition, there was no discrimination based on other player demographics.[2]

In this study guards had a significantly greater rate of non-contact injury when compared to their forward/center counterparts. This finding is opposite of a previous report that centers had the highest injury rate regardless of MOI.[4] There are a couple

potential explanations for this finding. First, the centers studied in Meeuwise et al[4] were members of collegiate teams in Canada. There may be regional differences in game strategy that increased injury risk in that population. For example, the Meeuwise et al[4] study (which was published 2003) may have reflected offensive and defensive strategies emphasizing play involving the center. Reported injury rates by court location found "the key" region had the highest rates of injury: 0.34/1000 AEs for injuries causing ≥ 7 missed AEs and 1.86/1000 AEs for injuries causing < 7 missed AEs (the region with the second highest injury rate for injuries causing < 7 days of time-loss was the midcourt at 0.28/1000 AEs).[4] A second potential reason may be due to the combining of centers and forwards into one category in the current study. This was done due to the overall low numbers of centers enrolled in the study. It can be argued that many forwards and centers have similar roles on the court, on both the offensive and defensive ends, and therefore may have a similar risk profile. Since this is a preliminary study, the inclusion of additional team data over the three or more year study period may allow for eventual comparison between guards and forwards/center as well as comparisons between guards, forwards, and centers. A third potential reason for injury rate differences between guards and forward/centers may have to do with off-season/preseason training habits, although this only speculative. For example, it is possible that the training programs performed by centers (who were observed during the Meeuwise et al study[4]) were not adequate to reduce injury risk. However, there is limited data in the literature detailing off-season training habits and future risk of injury in various BB populations. One study has reported off-season training habits based on level of competition and per player position.[31] NAIA forwards/centers devoted significantly greater amounts of time to cardiovascular exercise and plyometric exercise than those who competed at the NCAA Division III level during the six-week period prior to the start of the official preseason.[31] NAIA forwards/centers also devoted significantly greater amounts of time to plyometric training than their guard counterparts.[31] This study however did not evaluate risk of injury based on off-season training habits.[31]

It was hypothesized that starters would be at a greater risk for injury compared to their non-starter counterparts. This relationship was hypothesized because starters may have greater exposure to injury due to playing more minutes per game. However, starters were no more likely to experience a time-loss injury (contact or noncontact) than their non-starter counterparts. This finding is consistent with a prior report that found no greater risk of injury based on starter status.[5] While it might be assumed that starters would be at a greater risk based on having a greater exposure to injury due to minutes played in games; the overall time spent playing during games is only a small fraction of the total time spent playing basketball during practices and games during the course of a season.

Limitations of this Study and Recommendations for Future Investigations

There are some limitations to this study that warrant discussion. First, the sample size utilized in this study is relatively small; especially in relation to previously published multi-year studies.[1-3] Previous multi-year studies presented injury rates based on populations consisting of tens to hundreds of thousands of AE. For example, Dick et al reported injury rates based on over 45,000 game-related AEs and over 140,000 practice-related exposures.[1] To provide perspective, the total number of AE in the current study neared 10,000. Despite the large difference in total AE, this study presents rates that are either novel or that differ from prior reports. As previously mentioned, this is a preliminary report that is part of an on-going multi-year investigation. A second limitation to this study relates to the proportion of athletes represented per level of competition. The largest population of athletes based on level of competition were from Division III teams. Athletes from the Division III level had the highest rates for time-loss LQ injury and thus may have skewed overall injury rates higher. Recruiting additional athletes from other levels of competition may result in different overall non-contact time-loss injuries of the LQ. Finally, this study explored relationships between prior injury history, player position, and starter status. While some significant relationships between rates and risk profiles were identified, other potential risk factors were not able to be

assessed. For example, in this study all guards were combined in one category. It is possible that point guards, because of their position requirements, have a greater risk of injury than shooting guards; however, this is currently unknown. Future research should focus on the potential relationship between specific player positions and injury.

CONCLUSIONS

The results of the current study indicate that guards experienced a greater rate of LQ injury than their forward/center counterparts. Starters and athletes with prior history of injury were no more likely to be injured when compared to nonstarters or to those with no prior history of injury. Athletic trainers and other sports medicine professionals should consider this data when developing injury prevention programs for their athletes.

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